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PLM systems for the apparel industry: Current status according to the literature

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Introduction. Product life cycle management (PLM) systems were introduced in the 1990s to consolidate the product related data that covers start to end process of new product development (NPD) for the companies including their suppliers and partners across industries in which the new system complements previous product data management (PDM) system (Cantamessa, Montagna & Neirotti, 2012). The R&D, design and production teams of apparel companies are often scattered in remote geographic locations in order to overcome barriers associated with lead-time and cost in a global market; hence, firms have strong needs to manage integrated product data efficiently in various locations (Luh, Pan, & Chu, 2011). Thus, there are growing needs for innovative technology to support NPD through global supply chain to achieve lower cost and shorter market-entry cycle in apparel industry (Jin, 2013). PLM is considered to be one of leading enabling technology for NPD (Gecevska et al., 2011). Currently, there is a lack of literature explaining the use of PLM in the apparel industry. Therefore, the purpose of this abstract was to review literature on PLM systems for sustainable NPD in the apparel industry. Specifically, the objectives of this review were to: (a) analyze the documentation of one company, (b) examine current state of PLM system implementation in apparel companies and (c) suggest future directions for research of PLM systems for the apparel industry.

Method. The status of PLM in the apparel industry was informed by *first*, analysis of the documentation provided by a large apparel company who is a user of an European PLM system provider and *second*, a comprehensive review of literature. The company provided documentary evidence and information including: (a) PLM system flow designs, (b) NPD process maps, (c) employee education manuals, (d) samples of a completed technical package for NPD designed in PLM systems, and (d) users' feedback reports. In order to compare similarities and differences in PLM system implementation between the apparel industry and others, depending on their business environment, a comprehensive review of literature published in other industries was conducted, such as engineering and manufacturing. Discussions in various online and off-line sources reporting related issues in the apparel industry supplemented the review, such as: (a) case studies of apparel companies in PLM system implementation, (b) websites including fashion retail brands, (c) major fashion PLM system providers (e.g., IBM, Lectra, Oracle, PTC, SAP, Siemens and etc.), (d) information technology news (e.g., *Science Daily*, *Computerweekly* and etc.) and (e) technology section of major news (e.g., Bloomberg, CNN, Economist and etc.).

Results. The results of the information reviewed confirm a lack of scholarly research about PLM in the apparel industry. Review of documentary evidence of the apparel company that participated in this study demonstrates that almost all of NPD work processes have been adopted in their PLM system flow to reduce inefficient paperwork or off-line procedures. The company has been evolving their PLM system continuously as new needs or changes of market situation occur. Previous studies related to PLM in other industries like engineering and

manufacturing present that research on PLM have been established in several major areas: (a) relationship between process innovation and PLM system implementation, (b) compatibility of NPD process and PLM system design and (c) PLM as a business strategy of the company and users' acceptance of new PLM system. Case studies of fashion retail companies, published information at web sites of major PLM system providers and information technology news illustrate that the PLM systems in the apparel industry are concentrated on potential benefits to reduce NPD lead-times and costs. The PLM system capabilities of flexibility and promptness are significant because of the rapidly changing and complex market environment in the apparel industry. The current PLM system applications in most apparel companies except a few large companies turn out to be still in the early stages of implementation, so, complete NPD work process has not been applied to most systems. Small to medium sized companies in engineering and manufacturing industry have also shown similar phenomenon to the apparel companies in limited implementation of NPD work process in their system.

Conclusions. The findings of this study suggest that future research on the PLM systems in the apparel industry should answer following questions: (a) Why is the process innovation is critical to the PLM system implementation for apparel firms?, (b) What is the compatibility standard between NPD process and PLM system design in apparel firms?, and (c) What factors affect the users' acceptance of PLM in apparel firms? It would be important for these questions to be answered not only for the benefits to the apparel companies, but also for consumers and supply chains in terms of faster delivery of products at lower price offered in the market and for academics preparing students to use PLM systems. It is clear that apparel companies should obtain competencies to provide products that satisfy timing, performance and price for consumers to beat their competitors. Therefore, it would be important for executives of apparel companies to recognize that integrated product data management technology such as PLM systems is essential to ensure to the company's NPD capability enhancement and longevity of the firms in the long run. Future studies are also needed to explore to the impact of PLM different types of companies along the supply-chain in the apparel industry, such as manufacturers, suppliers, sourcing agents and retailers to identify its impact on competitiveness.

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